SOFT INELASTIC X-RAY SCATTERING (SIX)

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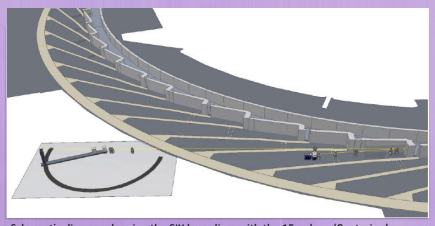
TECHNIQUE AND CAPABILITIES

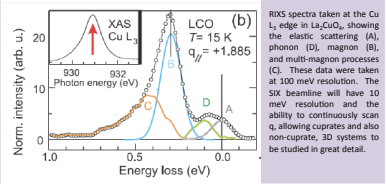
- Resonant inelastic x-ray scattering (RIXS) at unprecedented resolution (10 meV @ 1000 eV) to revolutionize study of low energy excitations in many important materials.
- Continuously tunable momentum transfer (q) to study the dispersion of excitations in condensed matter.
- Soft X-ray energy range (~260-2000 eV) to access transition metal L edges, rare earth M edges, and the K edges of C through Si.
- Focused beam (3x10 μm) to study small crystals / micron scale patterned device structures.
- Two endstations using an EPU source: an ultrahigh resolution 'Centurion' endstation (R=100,000) and a high throughput 'Viking' endstation (R=5000).



Schematic diagram showing the SIX beamline, with the 15 m long 'Centurion' spectrometer located in a satellite building.

Close up view inside the ring building showing the high throughput 'Viking' endstation.

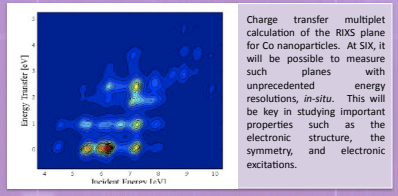
APPLICATIONS



RIXS spectra taken at the Cu L_3 edge in La_2CuO_4, showing the elastic scattering (A), phonon (D), magnon (B), and multi-magnon processes (C). These data were taken at 100 meV resolution. The SIX beamline will have 10 meV resolution and the ability to continuously scan q, allowing cuprates and also non-cuprate, 3D systems to be studied in great detail.

Complex Materials for Advanced Technologies

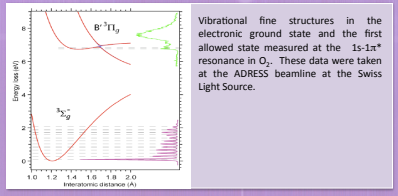
Enables the study of magnetic, orbital, phonon, and Kondo excitations in correlated electron materials and heterostructures-> potential applications in high Tc superconductivity, multiferroics, and CMR materials.



Charge transfer multiplet calculation of the RIXS plane for Co nanoparticles. At SIX, it will be possible to measure such planes with unprecedented energy resolutions, *in-situ*. This will be key in studying important properties such as the electronic structure, the symmetry, and electronic excitations.

Chemical and Energy Sciences

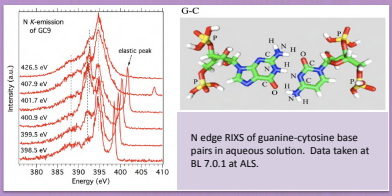
The size dependency of the electronic structure (which is a key factor determining reactivity) of nanoparticles holds the potential to create novel, tailored materials. RIXS allows both the occupied and unoccupied density of states to be measured *in-situ*.



Vibrational fine structures in the electronic ground state and the first allowed state measured at the 1s-1π* resonance in O_2. These data were taken at the ADRESS beamline at the Swiss Light Source.

Atomic and Molecular Sciences

The nature of the RIXS process will serve as an experimental test-bench for advanced quantum chemical theory, including the behavior of highly excited states, ultrafast wave packet dynamics, and role of localization and symmetry.



N edge RIXS of guanine-cytosine base pairs in aqueous solution. Data taken at BL 7.0.1 at ALS.

Life and Environmental Sciences

The ability to study liquid systems in-situ will allow studies of active centers of large biomolecules in an aqueous environment, homogenous catalysis, and complex processes at mineral surfaces, for example.

ADDITIONAL INFORMATION

- Achieving the ambitious goal of 10^5 resolving power at 1 keV requires several key components and technical accomplishments, including:
  a. State-of-the-art gratings - VLS plane gratings with 0.05 μrad figure error.
  b. Micrometer level stability of several key optical components over distances of ~ 50 m.
  c. A 15 m large spectrometer located in a satellite building.
  d. High sensitivity soft x-ray detector capable of operating at near grazing incidence.